



Kotzebue Electric Association Wind Projects

Brad Reeve

General Manager

Kotzebue Electric Association Inc.

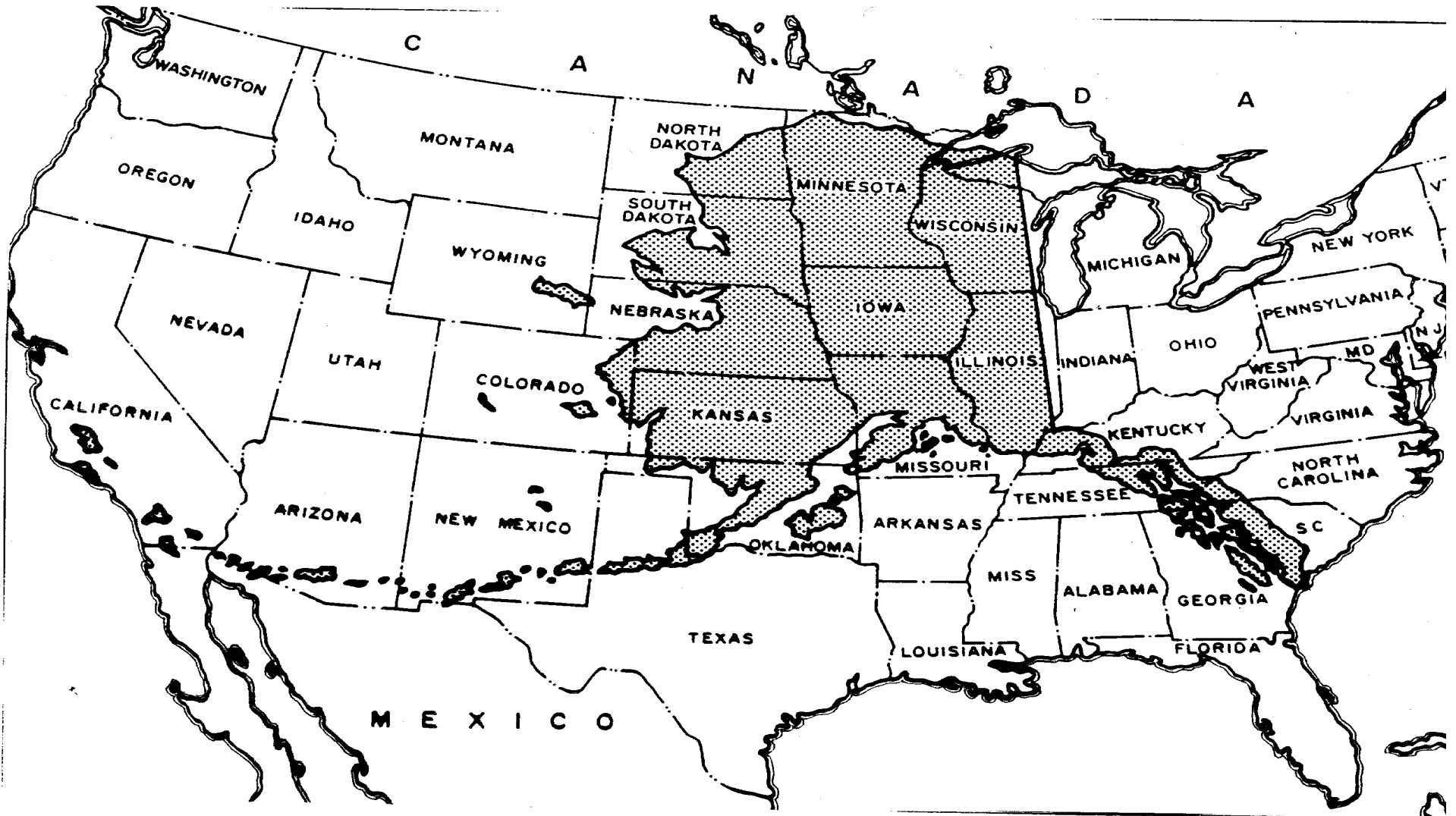
Wind Diesel Conference

Anchorage, Alaska



KOTZEBUE
ELECTRIC ASSOCIATION

Alaska





Alaskan Statistics

- Area 586,000 square miles
- 1996 population 607,800
- Lowest recorded temperature -80° F on 1/23/71 @ Prospect Creek
- Largest cities:

Anchorage	248,296
— Fairbanks	33,281
— Juneau	29,078
— Sitka	9,052
- Approximately 67,000 Alaskans live in 160 rural communities



Energy is Expensive In Rural Alaska

Urban kWh average cost \$.10

Hub communities \$.20

Villages \$.40

Logistics

- No roads or interties
- Air and/or barge only access for freight
- Many coastal areas "iced in" most of the year
- Most electricity is diesel generated
- Very significant reserve generating capacity



History of Wind Development in Alaska

- In the early 1980's there were 140 state and federally sponsored wind generators installed across Alaska
- The vast majority were out of commission within a year
- Wind as a technology was seen as unreliable and further efforts were abandoned



What was missing?

- Utility involvement
- Manufacturing support in Alaska
- Cold weather design features
- There was no supporting infrastructure
- Early equipment wasn't ready for Alaska



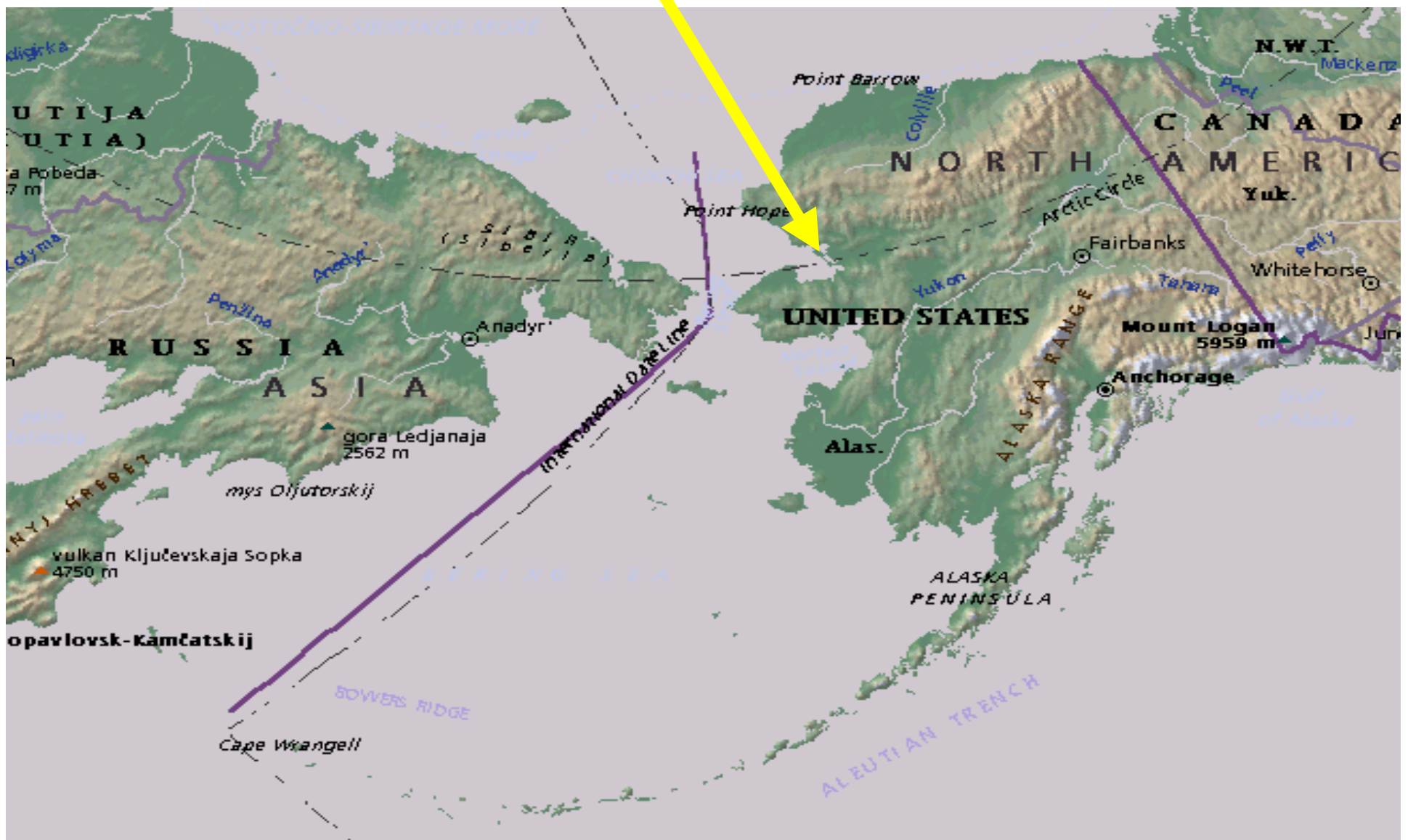
Wind where does it Plug In?

The successful integration of wind in Rural Alaska will be the combination of wind and other forms of generation



Kotzebue : pop 3705

30 miles north of Arctic Circle





KEA Background



- Consumer owned electric cooperative
- Member elected Board of Directors
- 1,200 consumers
- 11 MW diesel plant
- 17 miles of distribution
- 21 million kWh, annual sales



Kotzebue, Alaska

- Hub for 10 communities
- 30 miles above the Arctic Circle
- Population: 3,750
- 75% Inupiat Eskimo
- Located in the NW Arctic Borough, larger than Illinois
- UAF Branch Campus
- Alaska Technical Center





Kotzebue, Alaska

A Unique Environment

- North of the Arctic Circle on the tip of Baldwin Peninsula
- Access year round by air and 3 months by sea
- Low, flat terrain consisting of tundra and permafrost
- Annual average temperature -5.8°C (22°F)
- Average snowfall – 127 cm (4.2 feet)
- Winter wind-chill temperatures to -120°F



Wind Turbines Must be Reliable

- Winter maintenance is extremely challenging and at times impossible
- Minimal or no crane or tilt up towers
- Comprehensive training of local utility and/or operations personnel is essential to success
- Packaging for air / barge shipment is critical
- Cold weather materials and features
- Staging of spare parts is important



Kotzebue Wind Power Project

- 10 – AOC 15/50 turbines
 - 3 installed July 1997
 - 7 installed May 1999
 - 2 to be installed 2002-03
- Rated Turbine Capacity
 - 66 kW continuous rating
- 1 – Polar 100 turbine
 - installed April 2002
- Rated Turbine Capacity
 - 100 kW continuous rating





Kotzebue Wind Project Goals

- To show that wind can work in Alaska
- Reduce diesel consumption for KEA and the community
- Develop high penetration wind projects that provide electric and thermal energy for communities
- Develop cost effective Arctic foundations
- Develop tilt up tower design for small villages
- Develop safety & training program for wind systems
- Document operations and maintenance costs
- Establish a cold weather technology center

Atlantic Orient Corporation

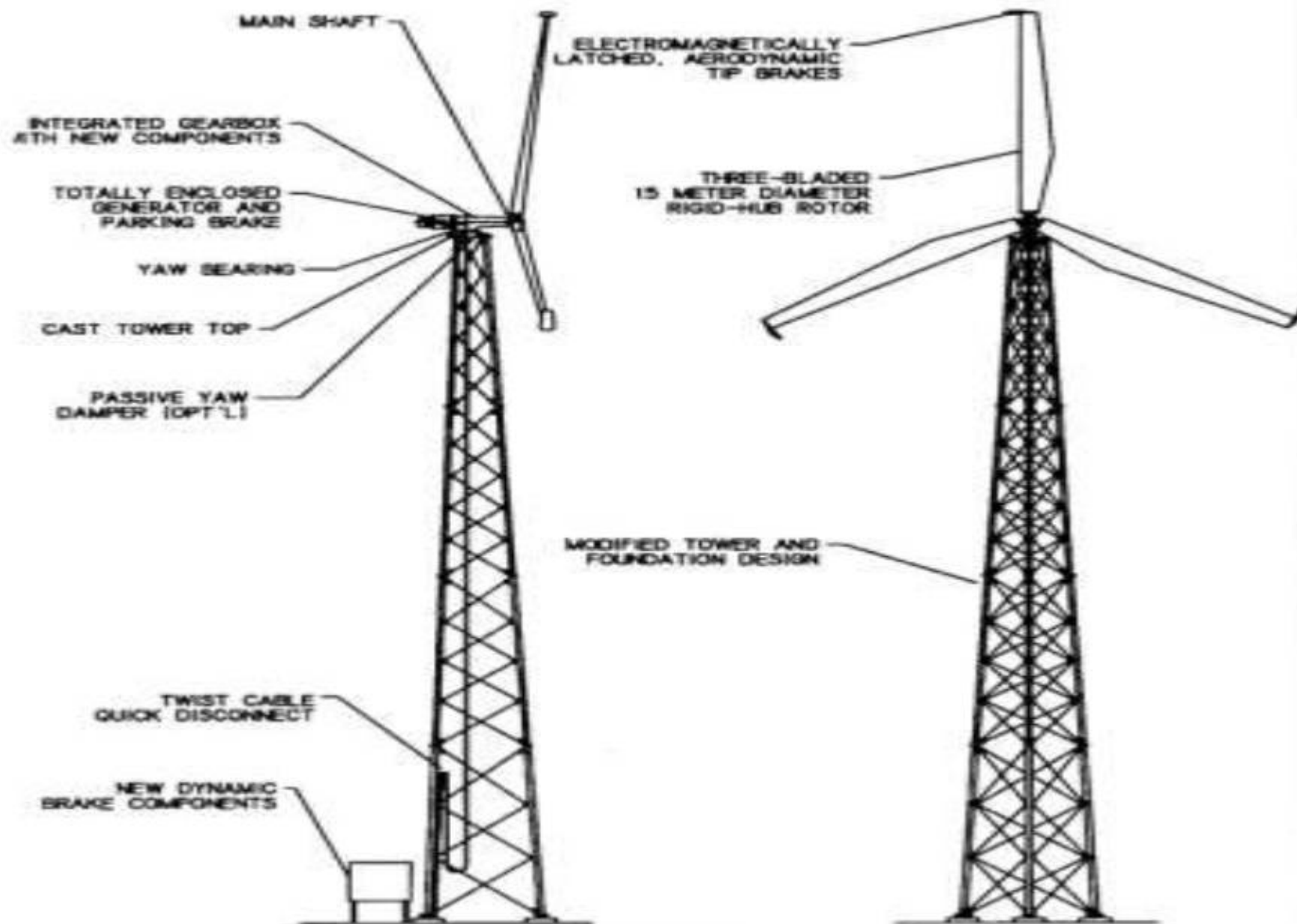
15/50





Why Atlantic Orient Corp. (AOC) ?

- We were looking for a machine that would work in the cold, and smaller villages
- The predecessor of the AOC, Enertech 14/40, was a highly dependable machine that is still in use in California
- The AOC 15/50 was developed from a Failure Mode Analysis of the Enertech 14/40
- The AOC 15/50 was tested through the Advanced Turbine Design program at NREL
- There wasn't anything else available that fit the need



AGC 15/50



Northern Power Systems

Polar 100 kW

Polar 100 is a direct drive wind turbine

- We were looking for a non-induction type turbine
- We wanted experience with other turbines
- Polar 100 uses a different foundation with a tubular tower
- KEA will compare performance with another unit housed at NREL
- Kotzebue wind regime will be used to test cold weather operation

Northern Power Systems Polar 100 kW





Project Construction





Arctic Foundations





Tilt Up Towers





KOTZEBUE
ELECTRIC ASSOCIATION

Rural Employment





Arctic Fashion

- Well Dressed Arctic Workers use
 - Seal or Beaver Hats
 - Goggles
 - Carhart Snow Suits
 - Bunny Boots

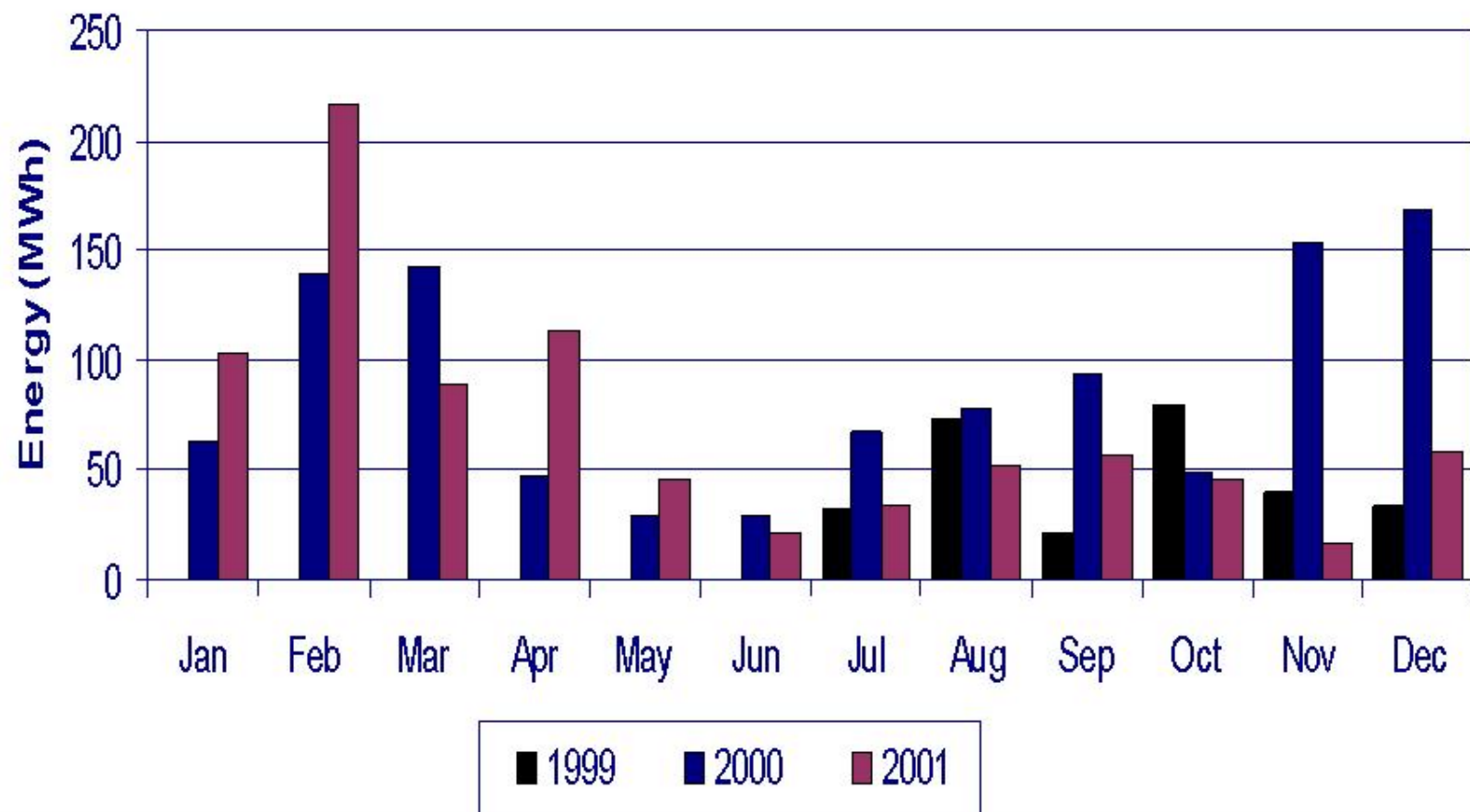




Results to Date

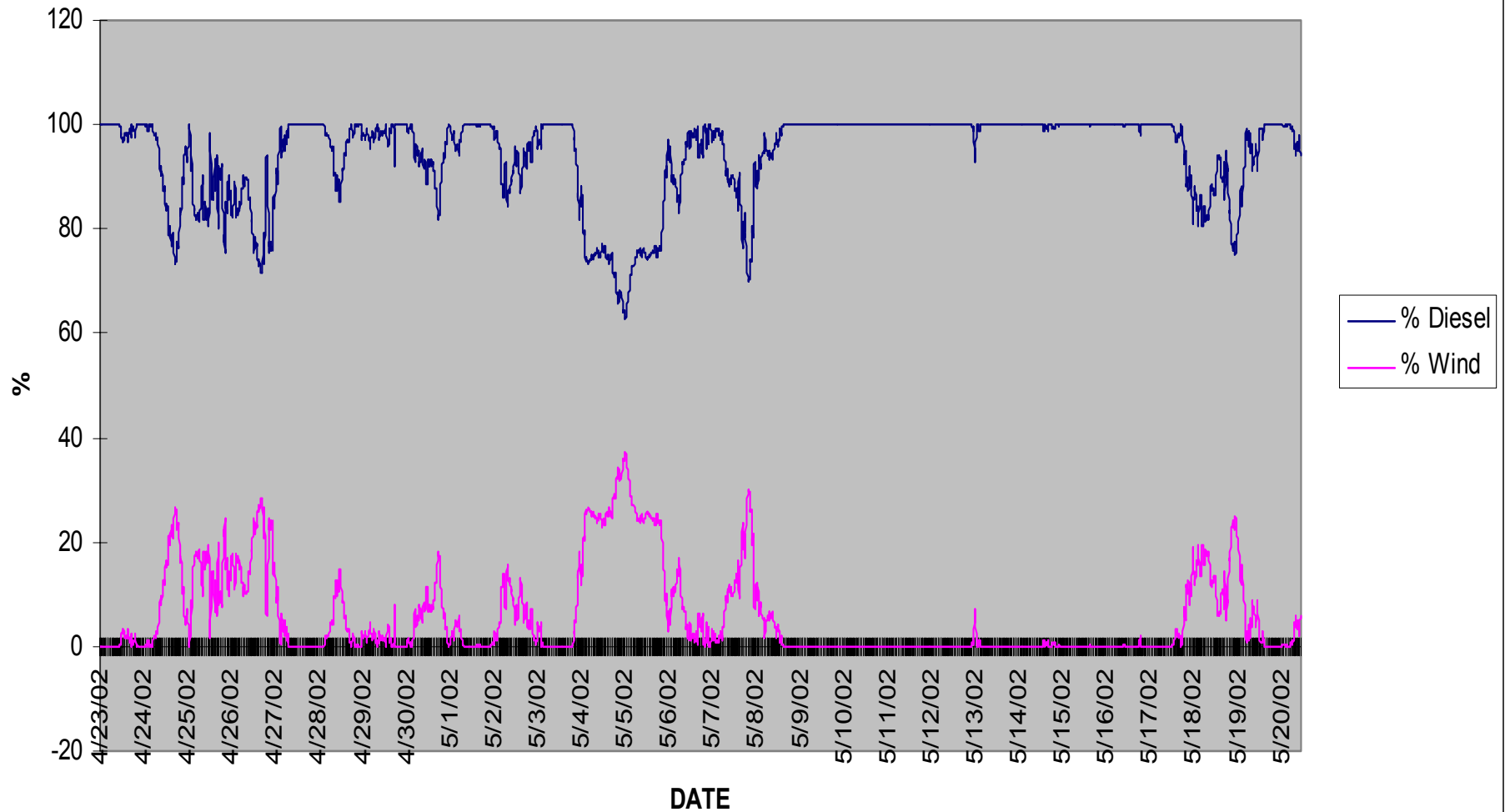
- Initial project operational since May 1997
- Initial turbines have operated through 5th winter
- With 10 operational turbines KEA has seen 39% penetration with no frequency issues and no negative effect to consumers
- Power plant has seen low power factor at low system loads with high wind production (low diesel)
- Project has produced over 3 million kWh to date
- Power quality research was positive
- Economic results looks positive
- Maintenance and operations costs have been low

Energy Production

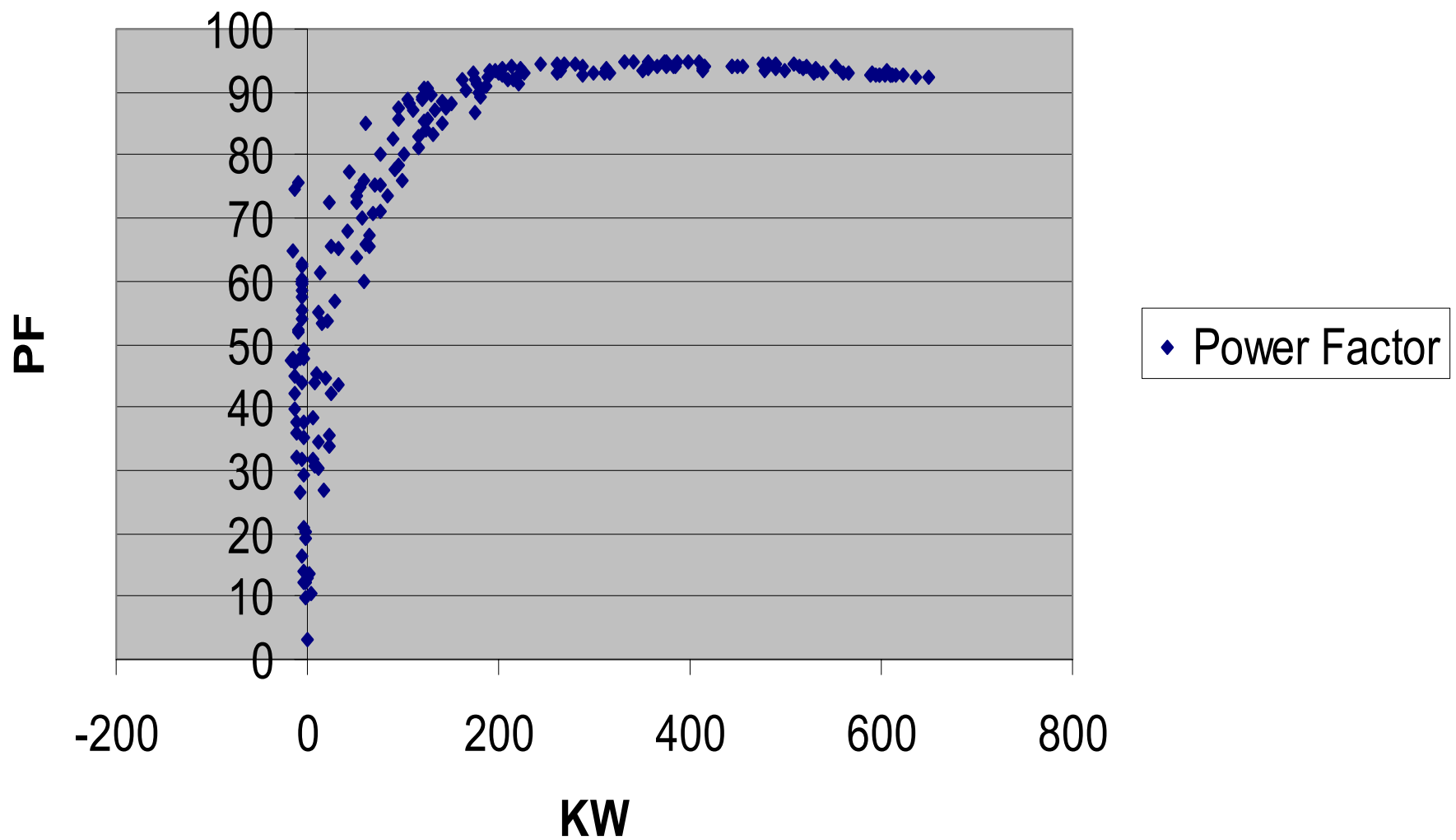


KEA % WIND & DIESEL 5-02

Wind Penetration Peak 37%



KEA Windsite PF versus KW





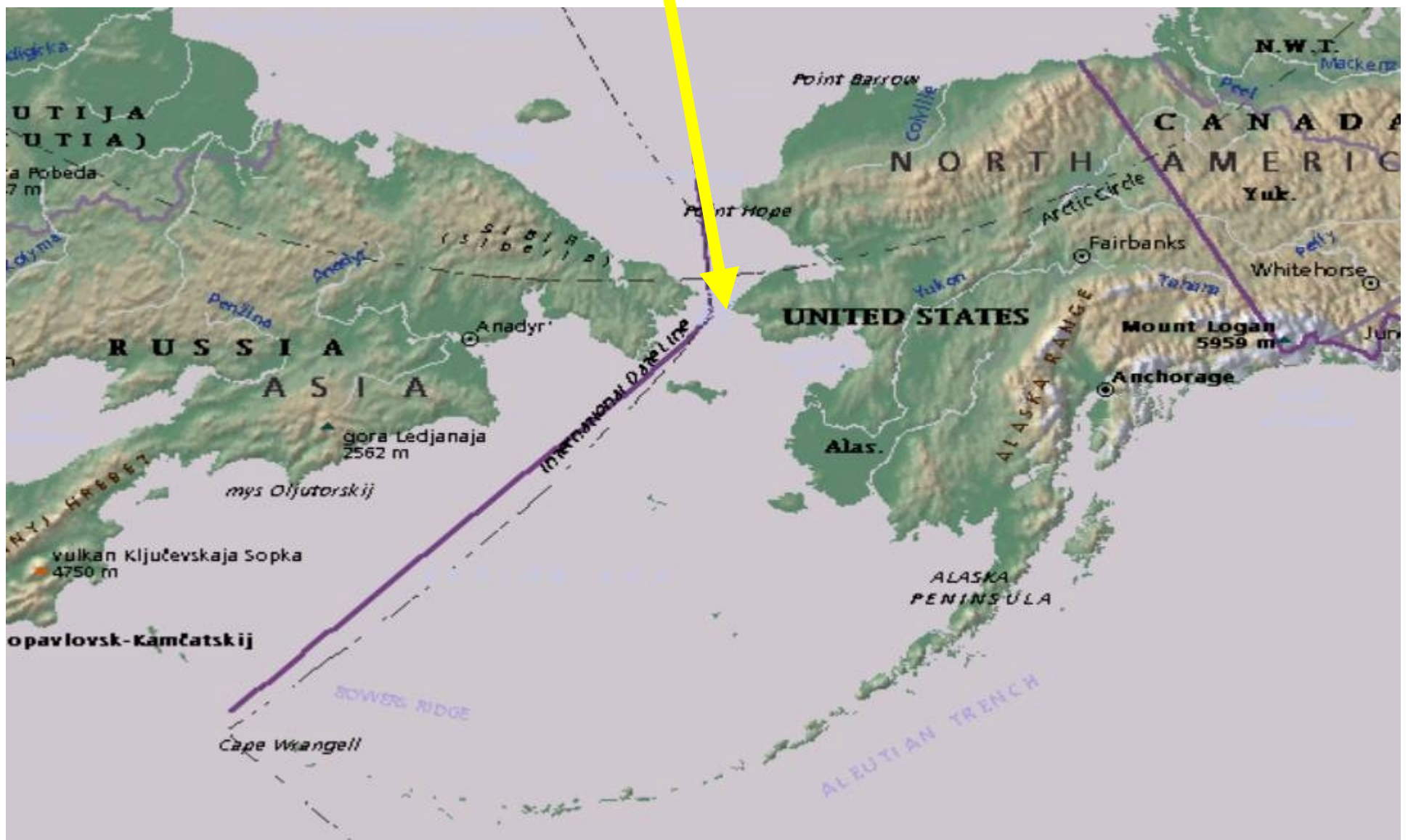


Community Acceptance

- Wind Energy Development has been a positive community relations tool
- Seen as a positive example of rural economic development
- For Kotzebue it is best available local resource, no local gas, coal, hydro availability

Wales Alaska

Located at the Tip of Seward Peninsula





KOTZEBUE
ELECTRIC ASSOCIATION

Wales Alaska





KEA-AVEC ASTF/EPA NREL Wales Wind Diesel Project

KEA and AVEC, State of AK., ASTF, EPA-Innovative Technology Program, contributions from NREL,

Up to 150% penetration with wind.

Project Scope - to use 2 wind turbines, to replace diesels electrically and thermally. System will use short term battery storage, rotary converter. A system controller (PLC) will be used to manage the wind and diesels.

Excess energy from project will heat school



KOTZEBUE
ELECTRIC ASSOCIATION

Shipping - Wales



Turbine Erection - Wales



Turbines - Wales





KOTZEBUE
ELECTRIC ASSOCIATION

System Controller - Wales



Secondary Heat - Wales





Wales Wind Diesel Project

- Wind turbines have been operational for a year
- Recovered heat boilers are operating at the school and the diesel plant
- The system controller is operational
- Battery bank and rotary converter are operational
- Testing of system will continue for one year
- Project ran diesels off for 100 hours in August



This was a huge effort by everyone involved

- Village was converted to 3 phase
- Diesel generators was converted to 3 phase
- School was converted to 3 phase
- Generator pitch was mis-matched between units
- Plant cooling system needed redesign and upgrade
- Fuel system needed to be upgraded
- The PLC program for the wind turbines was redesigned



Thanks to

- KEA staff – Matt Bergan, Steve Apgar, Mike Lawlor
 - AVEC – Mark Tietzel, Jon Lyons, Brent Petrie, Bill Crisi,
 - NREL – Steve Drouilhet, Mari Sharazi
 - Thompson Engineering – Craig Thompson, Glen Pomeroy
 - ITI – Malcolm Lodge
 - AIEDA – Dennis Meiners
-
- Funders
 - Alaska Science and Technology Foundation
 - EPA
 - AIEDA
 - NREL
 - KEA
 - AVEC